

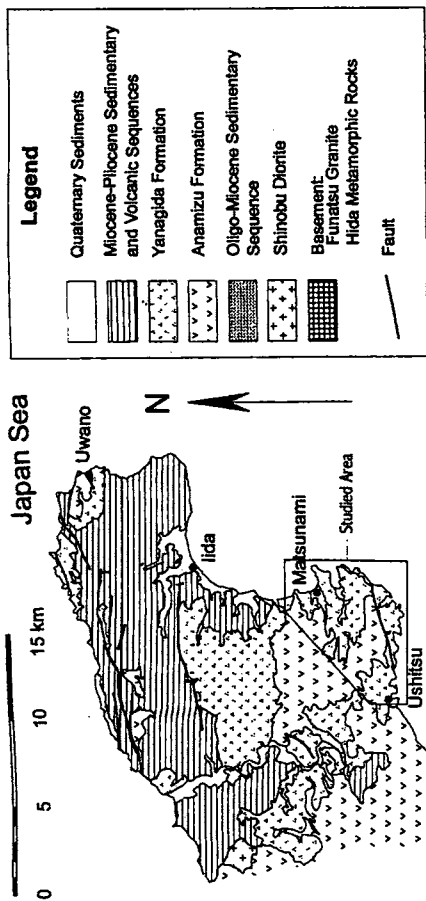
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学位授与の題目	Petrogenesis of the tholeiitic basalt, calc-alkaline basaltic andesite and high magnesian andesite lava succession of the Oligo-Miocene Anamizu Formation in northeastern Noto Peninsula, central Japan
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## 学 位 論 文 要 旨

### ABSTRACT

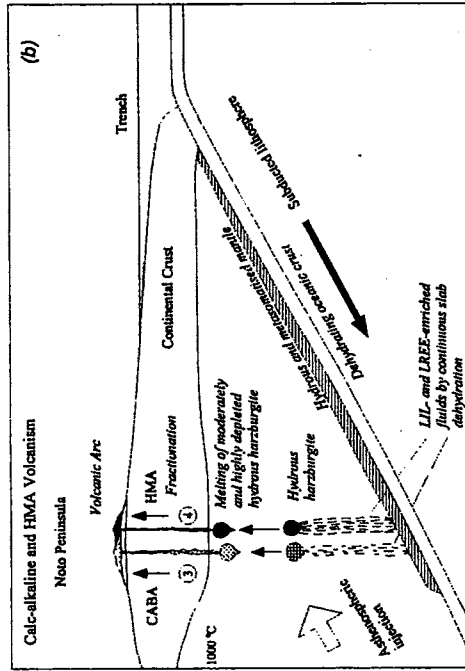
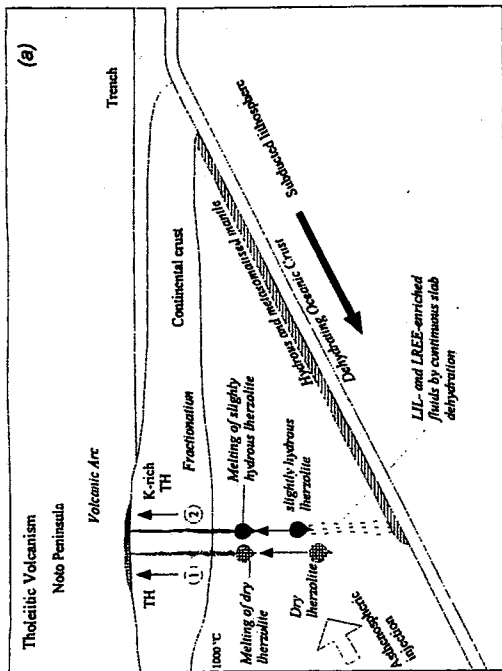
The Oligo-Miocene Anamizu Formation in the Ushitsu-Matsunami area consists of a lower volcano-sedimentary member and an upper volcanic member. The upper member is composed of three lava series; tholeiite (basalt and basaltic andesite), calc-alkaline (basaltic andesite) and high-magnesian andesite (bronzite andesite), in ascending order. The tholeiitic basalt is further divided into K-poor and K-rich types. The tholeiitic basaltic andesite has higher  $\text{FeO}^*/\text{MgO}$  than the others. The calc-alkaline basaltic andesite has higher Cr and Ni than tholeiitic basaltic andesite. Bronzite andesite contains higher MgO, Cr and Ni than common calc-alkaline andesite, but lower than those of boninite and sanukite. All the rock series are depleted in HFSE (Nb and Ti) in comparison with N-MORB and OIB, suggesting typical subduction-related arc magmas. High Zr/Y ratios of the tholeiitic basalt resemble those of active continental margin magmas rather than island-arc magmas. The HFSE, Ni and Cr compositions indicate a progressive depletion or increasing degree of partial melting of the mantle wedge source in the order tholeiite basalt (basaltic andesite)→calc-alkaline basaltic andesite→bronzite andesite. Spinel in the three series shows different trends: Cr-poor in the tholeiitic basalt, fairly Cr-rich in the calc-alkaline basaltic andesite, and Cr-rich in the high-magnesian andesite.  $^{87}\text{Sr}$ - $^{143}\text{Nd}$  isotope ratios exhibit three groups, respecting to  $^{87}\text{Sr}$  enrichment: tholeiitic basalt (relatively depleted), calc-alkaline basaltic andesite (fairly enriched) and bronzite andesite (enriched). Spinel trends indicate different mantle restites; lherzolite for the tholeiitic basalt and harzburgite for the calc-alkaline basaltic andesite and high-magnesian andesite, and increasing degree of depletion in

the order as above. On the contrary, LILE and LREE exhibit a gradual enrichment of the source in the same order. Sr and Nd compositions indicate contamination of mantle source by hydrous fluids, and subsequent interaction of the primary magma with the continental crust (Hida gneiss). Corresponding decrease of  $\text{TiO}_2/\text{K}_2\text{O}$  suggests that the enrichment has been due to addition of fluids derived from the descending slab. These data indicate that the K-poor tholeiitic basalt magma has been formed by partial melting of the lherzolitic upper mantle wedge under almost anhydrous conditions; whereas the K-rich tholeiitic basalt magma may have been produced by partial melting of the metasomatized lherzolitic mantle source under slightly hydrous conditions. The calc-alkaline and bronzite andesite magmas have been produced by partial melting of the hydrous, metasomatized, harzburgitic mantle wedge. The stratigraphy of the lava succession in the studied area (tholeiite basalt-basaltic andesite→calc-alkaline basaltic andesite→bronzite andesite) indicates that depletion and hydration (metasomatism) of the mantle source have progressed simultaneously.



Lithostratigraphic Succession of the Anamizu Formation in Ushitsu-Matsunami Area

Series	Lithostratigraphic Unit	Column	Thickness (m)	Petrography
Oligocene	Lower Member	THB	>100	Rhyolitic, dacitic and andesitic pyroclastic rocks
		HMA	10	Aphanitic bronzite andesite lavas
Miocene	Lower Member	CABA	15	Calc-alkaline basaltic andesite lavas
		THBA	10	Tholeiitic basaltic andesite lavas
Miocene	Lower Member	THB	>2	K-rich tholeiitic basalt lavas
		THB	20	Tholeiitic basalt lava
Miocene	Lower Member	THB	15	Tholeiitic basal autobreccia
		THB	>30	Volcanic conglomerate and red mudstone



Models of successive generation of tholeiitic, calc-alkaline and high-magnesian andesite magmas within an active continental margin. a) Tholeiitic K-poor and K-rich magmas may have derived from anhydrous and hydrous (metasomatized) mantle sources respectively. b) Calc-alkaline and high-magnesian andesite magmas may be generated from a hydrous residual peridotite, metasomatized by fluids coming from the subducted slab (after Hickey and Frey, 1982; Tatsumi, 1991).

## 学位論文審査結果の要旨

本論文は、能登半島北東部能都町・内浦町地域に分布する、様々な化学組成の溶岩からなる第三紀中新世前期の地層について、岩石学的成因を論じたものである。一般に無人岩、讃岐岩など高マグネシア安山岩の成因は、島弧前縁域における含水マントル溶融説が主流だが、本地域は島弧の背後側に位置し、このような場での高マグネシア安山岩マグマの成因は岩石学的に興味深い問題である。著者は、詳細な野外調査に基づき溶岩の層序関係を決定し、多数の岩石標本の顕微鏡観察、全岩化学組成および鉱物化学組成分析、そして Sr および Nd の同位体比測定を行った。その結果、溶岩層序から導かれるマグマ組成の時間的变化は、上位（後期）の高マグネシア安山岩が下位（前期）のカルクアルカリ安山岩やソレライトよりもマグネシウムやクロムに富み、これは単純な結晶分化作用では説明できず、給源マントルの組成変化や部分溶融程度の変化があったことを明らかにした。「上位のものほど液相濃集元素に富むが、マントルの溶融程度も大きかった」という結論は一見矛盾するように見えるが、沈み込み帯由来の液相濃集元素に富む流体に次第に汚染されつつあったマントルが、水の付加による融点低下によって溶融程度を増大させ、継続的なマグマ生成によって潤渇していったと考えれば矛盾なく説明できるとした。本論文の主要部分は既に英文の科学誌に印刷されており、その後得られた同位体組成のデータとそれに関する議論も加えられていて、火山岩研究の博士論文としては十分な内容と完成度をもつものと判断される。